GREAT LAKES INDIAN FISH AND WILDLIFE COMMISSION

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<u>Via Electronic Mail</u>

February 23, 2017

Technical Memorandum

To: Mr. Erik Smith, Industrial Division, Minnesota Pollution Control Agency

From: John Coleman, GLIFWC Environmental Section Leader

Re: Water Flow Pathlines from Minntac Basin East and Northeast Berm

The purpose of this memorandum is to more fully characterize waste water flow from the Minntac tailings basin to the surrounding surface waters features, including wetlands. The flows characterized here are those from the basin's east and northeast dike which discharge into the Sandy River watershed.

Discharges from the Minntac tailings basin into the Sandy River watershed are well documented by industry, state and tribal reports (e.g. STS 2007, MN-PCA 2016a, 1854 Treaty Authority 2016). Those discharges have reduced the abundant wild rice that once occurred in the Twin Lakes (Sandy and Little Sandy Lake) to a remnant of what occurred before discharges began. Because of the sensitivity of wild rice to sulfate, it is important that sulfate levels in the Sandy River be reduced to levels tolerable to rice. The Seepage Capture and Return (SC&R) system installed by U.S. Steel in 2010 captures approximately 10% to 50% of the high sulfate water discharging from the basin into the Sandy River watershed. Capture efficiency appears to vary by year and seasonally and was measured in the Twin Lakes as well as farther downstream (MN-PCA 2016a). Flowpath analysis by U.S. Steel consultants used particle tracking to characterize how water moved from the basin into the Sandy River watershed and how the SC&R system affects that flow. In this memorandum we use the same model to characterize how the approximately 50% to 90% of the basin discharge that is not intercepted by the SC&R system enters the Sandy River watershed. Pollutants in that uncontrolled discharge to surface waters (wetlands, the Sandy River, Admiral Lake and the Twin Lakes) must be limited in order to permit wild rice to grow in the Twin Lakes.

In 2013, Conestoga-Rovers & Associates (CRA), consultant for U.S. Steel, reported on the groundwater modeling they conducted of the east and north-east berm of the Minntac tailings basin (CRS 2013a) which discharges water into the Sandy River watershed. Later in that year, they reported on flowpath analysis to determine the time and distance of travel for water from the basin to the Twin Lakes (CRA 2013b). In the second report, CRA reported on particle tracking they conducted using the MODFLOW model reported in CRA 2013a and the MODPATH modeling software.

The particle tracking by CRA, using MODPATH for pathline analysis, focused on a very limited area of the basin's northeast berm. Figure 2 of the 2013b report (attached as our Figure 1) showed the path taken by a small number of water particle released at the northeast corner of the basin. CRA's particle tracking showed that some water discharged at the toe of the berm and some traveled under the sheet-pile to eventually emerge at the surface near PZ12.

Because of the very limited extent of the particle tracking conducted by CRA, the 2013b report did not reflect paths or travel times to other potential surface discharge points, i.e. either toe of berm, wetlands, rivers or lakes. To fill in this information gap, we conducted additional particle tracking using the CRA MODFLOW model (T65Fut) that was supplied to the MPCA on a CD as Appendix C to the 2013a report. Using CRA's model output files, we began by duplicating the particle tracking presented in their Figure 2 of the 2013b report. We then increased the number of particles released to include the entire north and eastern berm that was modeled by CRA in their 2013a MODFLOW model report. Our pathline analysis uses CRA's MODFLOW model output files and MODPATH. The only difference from CRA's work is that our analysis uses more released particles and, therefore, shows a more complete picture of the path that water takes from the basin to the toe of the berm and surrounding surface water features (our Figure 2).

Our MODPATH analysis, with more particles released, shows similar results as CRA's analysis in the northeast corner of the basin (area circled on our Figure 2); discharge to the toe of the berm in 1 to 2 years, arrival at the SC&R system in approximately 10 years and arrival at PZ12 in approximately 20 years. The slightly greater travel times in our MODPATH runs may be because we used the effective porosity values found in CRA's MT3D transport model (Layers 1to3 = 0.3, Layer 4 = 0.15) and CRA may have used some of the effective porosity values found in Table 7.1 of 2013a. Some of those porosity values in Table 7.1 are lower than the ones we used, which would explain their slightly shorter travel times. However, the location and length of the flowpaths would not be affected by porosity values.

There are two notable results from using more particles in the flowpath analysis. First, many flowpaths are relatively short with many being less than 100 meters in length. These are the flowpaths that terminate at the toe of the berm or in wetlands near the berm. The second is that some of the travel times are relatively short, with many being 1 to 5 years in duration (yellow, orange and purple arrows in our Figure 2). While some of the short flowpaths are captured by the sheet-pile SC&R, many are not and the flowpaths emerge either in an area where there is no SC&R or else emerge in wetlands beyond the SC&R.

When the full extent of the MODFLOW modeled area is examined (our Figure 3) similar results are apparent: many short flowpaths and some of short duration. Of particular note is that the model shows many short flowpaths to wetlands at the toe of the basin along the north berm. This is an area where no SC&R has been constructed. Those areas of discharge along the north berm are documented in a 2006 seep survey contained in the 2007 STS report titled "Subsurface Exploration and Seepage Evaluation" (STS, 2007). There are also many flowpaths that discharge to Admiral Lake and the Sandy River upstream of Admiral Lake. Of all the flowpaths, few flowpaths are in what CRA called the deep overburden and most are in the shallow overburden (our Figure 3).

In summary, flow pathline modeling, using CRA's model but with more particles released to more fully characterize flowpaths, shows:

- many paths emerge to surface water features (wetlands, pools and channels) at the toe of the basin berm or at a relatively short distance from the berm.
- only 13% of the flowpaths emerge to the land surface more than 500 meters from the toe of tailings basin berm.
- 51% of paths emerge to the surface within 100 meters of the toe of the berm.
- the vast majority of water flowpaths are mostly, or fully, within the shallow overburden.
- in many cases, flowpaths circumvented the sheet-pile to discharge to the surface beyond the

SC&R.

- along the northern berm there were many short flowpaths of less than 5 year duration that discharge to wetlands near the toe of the basin.

This analysis supports the need to regulate the discharges from the basin to surface water features and indicates that in most cases flowpaths are relatively short and shallow and discharge to surface water features and wetlands near the basin. These issues should be accounted for when drafting a NPDES permit for the Minntac basin discharges.

cc: Jonathan Gilbert, Director, GLIFWC Biological Services Division
Ann McCammon Soltis, Director, GLIFWC Division of Intergovernmental Affairs
Nancy Schuldt, Water Projects Coordinator, Fond du Lac Environmental Program
Kevin Pierard, Chris Korleski - U.S. EPA Region 5
Constance Cummins - U.S. Forest Service, Superior National Forest Supervisor

References:
(available at: https://gis.lic.wisc.edu/wwwlicgf/glifwc/Minntac/NPDES2016/)

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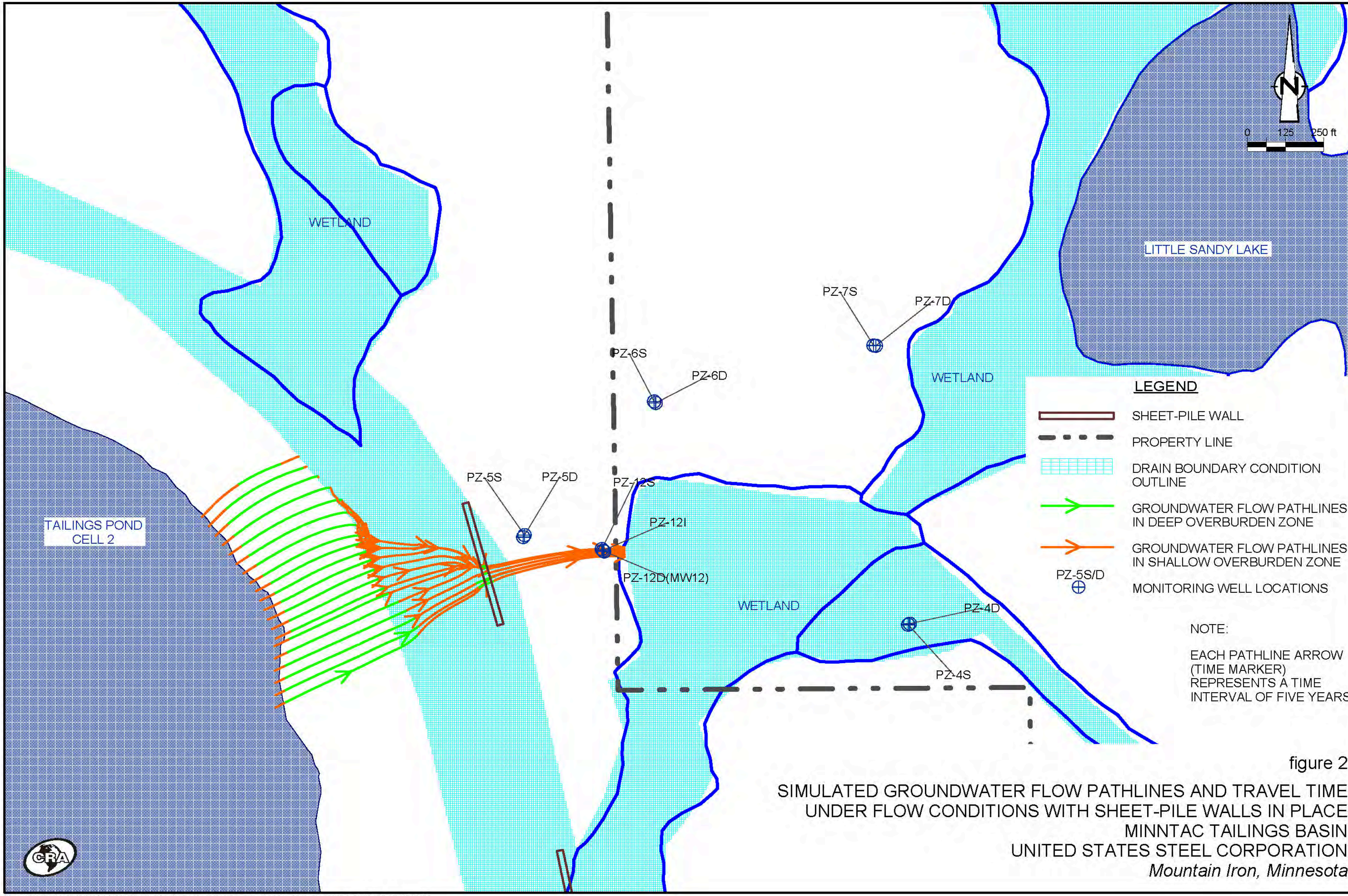
CRA, 2013a. Groundwater Flow And Sulfate Transport Modeling Report, Minntac Tailings Basin, U. S. Steel Corporation Mountain Iron, Minnesota. June 2013.

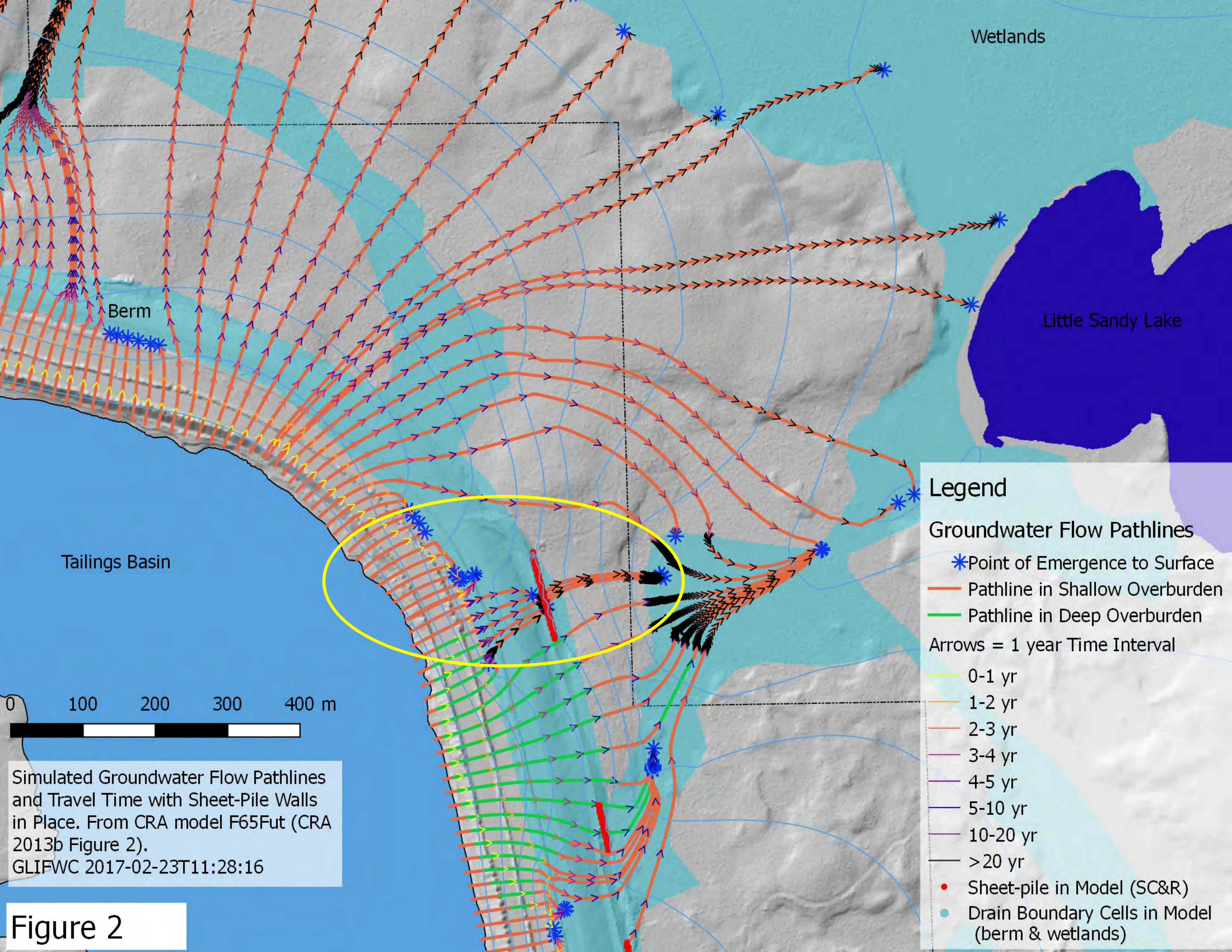
CRA, 2013b. Estimate of Time of Travel between the Tailings Basin and the Twin Lakes Minntac Tailings Basin, United States Steel Corporation, Mountain Iron, Minnesota. July 11, 2013.

MN-PCA, 2016a. Memo to File MN0057207. U.S. Steel Minntac Tailings Basin – Sulfate in Sand River and Twin Lakes – SCRS impacts



WETLAND
LITTLE SANDY LAKE
0
125
250 ft
PZ-7S
PZ-7D
PZ-6S
PZ-6D
WETLAND
LEGEND
SHEET-PILE WALL
PROPERTY LINE
DRAIN BOUNDARY CONDITION OUTLINE
GROUNDWATER FLOW PATHLINES IN DEEP OVERBURDEN ZONE
GROUNDWATER FLOW PATHLINES IN SHALLOW OVERBURDEN ZONE
PZ-5S/D
MONITORING WELL LOCATIONS
PZ-5S
PZ-5D
PZ-12S
PZ-12I
PZ-12D(MW12)
TAILINGS POND CELL 2
WETLAND
PZ-4D
PZ-4S
NOTE:
EACH PATHLINE ARROW (TIME MARKER) REPRESENTS A TIME INTERVAL OF FIVE YEARS
figure 2
SIMULATED GROUNDWATER FLOW PATHLINES AND TRAVEL TIME
UNDER FLOW CONDITIONS WITH SHEET-PILE WALLS IN PLACE
MINNTAC TAILINGS BASIN
UNITED STATES STEEL CORPORATION
Mountain Iron, Minnesota
053103-20(MEMO4)GN-WA-HYD (N:\HEG\53103\Memos\Memo04\Figures\053103-Pathlines-WithSheetpile.srf) JUL 11/2013

Figure 1



Wetlands
Berm
Little Sandy Lake
Tailings Basin
0
100
200
300
400 m
Legend
Groundwater Flow Pathlines
Point of Emergence to Surface
Pathline in Shallow Overburden
Pathline in Deep Overburden
Arrows = 1 year Time Interval
0-1 yr
1-2 yr
2-3 yr
3-4 yr
4-5 yr
5-10 yr
10-20 yr
>20 yr
Sheet-pile in Model (SC&R)
Drain Boundary Cells in Model (berm & wetlands)
Simulated Groundwater Flow Pathlines and Travel Time with Sheet-Pile Walls in Place. From CRA model F65Fut (CRA 2013b Figure 2).
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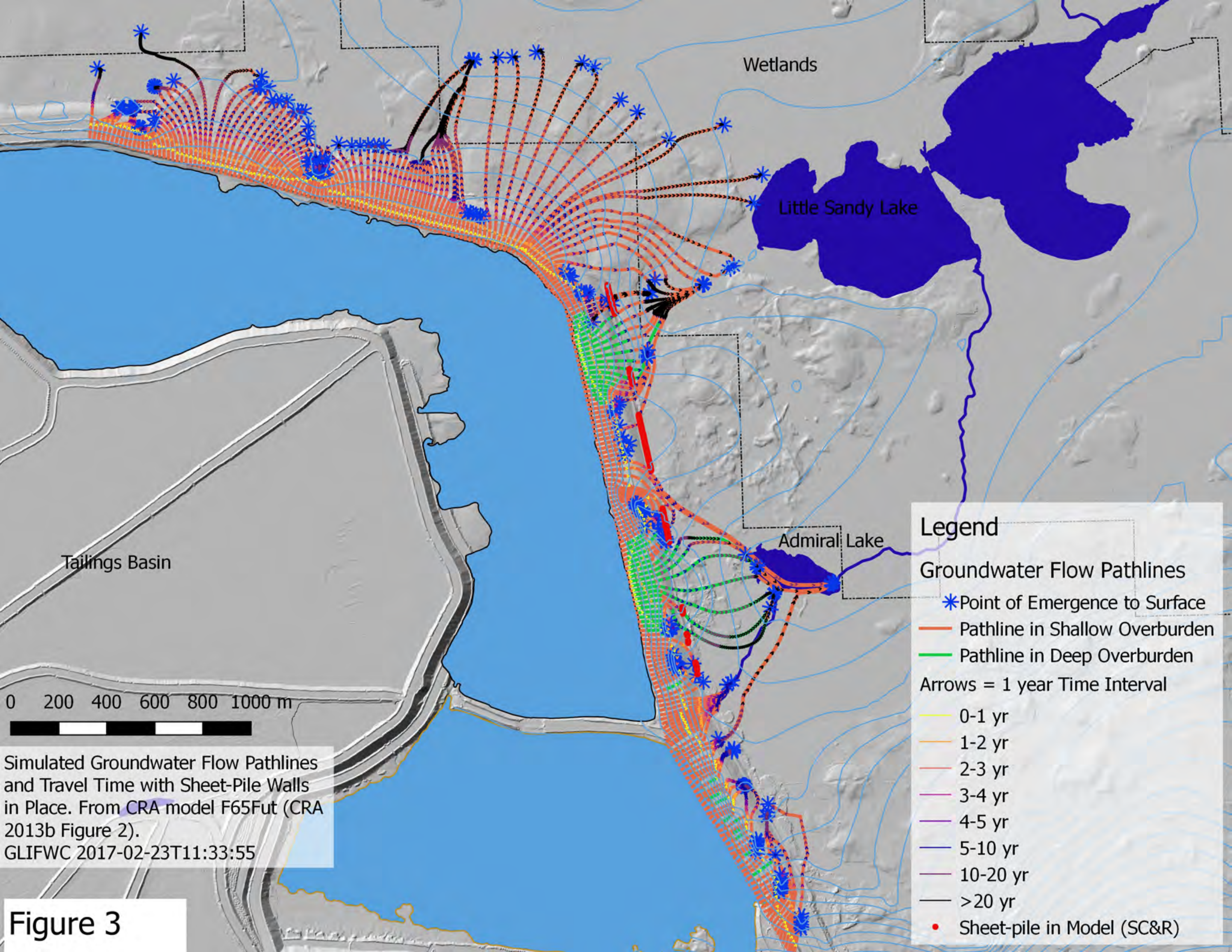
Figure 2



Simulated Groundwater Flow Pathlines and Travel Time with Sheet-Pile Walls in Place. From CRA model F65Fut (CRA 2013b Figure 2).
GLIFWC 2017-02-23T11:33:55

Figure 3